Express Mail Label No. EL 954591654 US

[0001] RAISING RANDOM ACCESS CHANNEL PACKET PAYLOAD

[0002] This application is a continuation of U.S. Patent Application No. 09/574,792, filed May 19, 2000, which claims priority from U.S. Provisional Application No. 60/134,899, filed May 19, 1999.

[0003] BACKGROUND

[0004] The invention relates generally to random access channels in a wireless code division multiple access communication system. More specifically, the invention relates to raising the packet data payload of packets transferred over a random access channel.

[0005] **Figure 1** depicts a wireless spread spectrum Code Division Multiple Access (CDMA) communication system **20**. A base station **22** communicates with user equipment units (UEs) $\mathbf{24_1}$-$\mathbf{24_n}$ in its operating area. In a spread spectrum CDMA system **18**, data signals are communicated between UEs $\mathbf{24_1}$-$\mathbf{24_n}$ and the base station **22** over the same spectrum. Each data signal in the shared spectrum is spread with a unique chip code sequence. Upon reception, using a replica of the chip code sequence, a particulardata signal is recovered.

[0006] Since signals are distinguished by their chip code sequences (code), separate dedicated communication channels are created using different codes. Signals from the base station **22** to the UEs $\mathbf{24_1}$-$\mathbf{24_n}$ are sent on downlink channels and signals from the UEs $\mathbf{24_1}$-$\mathbf{24_n}$ to the base station **22** are sent on uplink channels. For coherent detection of downlink transmissions by the UEs $\mathbf{24_1}$-$\mathbf{24_n}$, pilot signals are transmitted to all the UEs $\mathbf{24_1}$-$\mathbf{24_n}$ within the base station's operating range. The UEs $\mathbf{24_1}$-$\mathbf{24_n}$ condition their receivers based on the pilot signals to enable data reception.

[0007] In many CDMA systems **20**, random access channels are used by multiple users. One random access channel is a common packet channel (CPCH) which is used for uplink transmissions. A CPCH is capable of carrying packets of data from different UEs **24_1-24_n**. Each UE's packets have an associated uplink scrambling code which distinguishes it from other UE's packets. The CPCH is typically used to carry infrequently communicated data at high rates.

[0008] The CPCH as shown in **Figure 2** is time divided into frames **30_1-30_m** having time slots **28_1-28_n**, such as eight time slots proposed for the Third Generation Mobile Telecommunications System (IMT-2000)-UMTS. The UE **24_1** transmits a data packet over the CPCH using an assigned uplink scrambling code starting in a specific time slot. The packet typically lasts for multiple frames **30_1-30_m**. The uplink packets are used to carry data and control signals. The base station **22** receives and recovers data from the uplink data packet. Typically, a dedicated downlink control channel is established for use in sending control signals from the base station **22** to the UE **24_1** as well as other data.

[0009] **Figure 3** is a simplified UE **24_1** and base station **22** for transmitting and receiving packet data over a random access channel **42** in a CDMA system **20**. A data packet is generated by a data packet generator **32** at the UE **24_1**. The data is subsequently encoded for error protection, such as by convolutional encoding, by an encoder **34**. The encoded data is spread by a spreading device **36**, such as by mixing the encoded data with a spreading code. The spread data is modulated to radio frequency by a modulator **38** and radiated by the UE's antenna **40**.

[0010] The radio frequency signal is sent through a random access channel **42**, such as the CPCH, to the base station **22**. An antenna **44** at the base station **22** receives radio signals. The radio signals are demodulated by a demodulator **46** to produce a baseband signal. The baseband signal is despread by a despreading device **48**, such as by mixing the baseband signal with a replica of the original

spreading code. The de-spread signal is passed through a decoder **50** to recover the original data packet.

[0011] CDMA systems **20** typically use some form of adaptive power control. In a CDMA system **20**, many signals share the same spectrum. When a UE **24**$_1$ or base station **22** receives a specific signal, all the other signals within the same spectrum are noise-like in relation to the specific signal. Increasing the power level of one signal degrades all the other signals within the same spectrum. However, reducing transmission power levels too far results in undesirable received signal quality at the receivers. To maintain a desired signal quality at the minimum transmission power level, transmission power control is used.

[0012] Along with other data, both the UE **24**$_1$ and base station **22** send transmission power control (TPC) signals. The TPC signals tell the receiving UE **24**$_1$ or base station **22** to increase or decrease its transmission power level based on the quality of the received signals. Once the UE **24**$_1$ or base station **22** receives the TPC signals, it adjusts its transmission power level accordingly. For signals sent from the UE **24**$_1$ to the base station **22** on the CPCH, typically, a closed loop power control preamble (CLPC-Preamble) is used to carry the TPC signals. The CLPC-Preamble precedes other data being carried in the packet.

[0013] To assure that the initial power level of uplink communications is not set too high, the UE **24** initially sets its transmission power level at a sufficiently low power level. The initial power level is set such that it is highly unlikely that the transmitted data will cause a degradation to reception of other UEs. Both the UE **24**$_1$ and base station **22** have their transmission power levels adjusted to a desired transmission power level by the corresponding uplink and downlink TPC signals.

[0014] Until either the UE **24**$_1$ or base station **22** reaches a sufficient transmission power level, no data is being transferred. This lack of data transfer is

an inefficient use of the systems resources and is undesirable. Accordingly, it is desirable to increase data transfer in such systems.

[0015] SUMMARY

[0016] A data packet is provided for transmission having a first processing gain for reception at a first power level or higher. The data packet is modified prior to transmission such that the data packet has a preamble wherein data in the preamble has a second processing gain higher than the first processing gain for reception at a second power level lower than the first power level or higher. The user equipment unit transmits the modified data packet over the random access channel at a power level such that the modified data packet is initially received at the base station at at least the second power level. The transmission power level is adaptively controlled while the preamble data is transmitted such that the base station receives the data of the data packet having the first processing gain at least the first power level.

[0017] BRIEF DESCRIPTION OF THE DRAWINGS

[0018] **Figure 1** is an illustration of a typical wireless spread spectrum CDMA communication system.

[0019] **Figure 2** is an illustration of a common packet channel.

[0020] **Figure 3** is a simplified user equipment and base station.

[0021] **Figure 4** is an illustration of a data packet.

[0022] **Figure 5** is a flow chart of raising random access channel payload.

[0023] **Figure 6** is a simplified user equipment and base station for encoding a preamble at a higher encoding gain.

[0024] **Figure 7** is a simplified user equipment and base station for spreading a preamble at a higher spreading factor.

[0025] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] **Figure 4** is an illustration of a data packet **52**. The data packet **52** has preamble **54** and non-preamble data **56**. The length of the preamble may vary for differing systems and channel characteristics. A typical length being one or multiple frames. One type of preamble **54** is a CLPC-Preamble.

[0027] **Figure 5** is a flow chart of raising packet payload. For an initial packet or packets transmitted by the UE **24**$_1$ over the channel, the preamble **54** of the data packet **52** is modified to have a higher processing gain than the non-preamble data prior to transmission, **58**. For multiple packets, the higher processing gain will be used over a set number of frames. One approach for increasing the processing gain is to encode the preamble **54** at a higher gain than the non-preamble packet data. Another approach is to spread the preamble data **54** with a higher spreading factor than the non-preamble data **56**.

[0028] Initially, the UE **24**$_1$ transmits the data packet **52** over the random access channel, such as a CPCH, at a minimum power level, **60**. Since the processing gain of the preamble **54** is higher than the non-preamble data **56**, data within the preamble is recoverable at the minimum initial power level, **62**. As the received TPC signals adjust the UE's transmission power levels, the non-preamble data **56** will also be recoverable. Accordingly, the data throughput of the random access channel is increased. Subsequent packets will not require modification, since the transmission power levels will be at desired levels.

[0029] **Figure 6** is a simplified UE **24**$_1$ and base station **22** for use in raising packet payload. A data packet generator **32** generates a data packet **52**. The data packet **52** is separated into its preamble and non-preamble packet data, such as by a de-multiplexer **64**. The non-preamble packet data is encoded by an encoder **66**, such as by a rate 7/8 convolutional encoder, although other encoding schemes may be used. The preamble data is encoded using a preamble encoder **68** at a much

higher encoding gain, such as by a rate ½ to _ convolutional encoder. The encoded preamble and non-preamble data are reassembled, such as by a multiplexer **70**. The multiplexed packet is spread by a spreading device **36**, modulated to radio frequency by a modulator **38** and radiated by an antenna **40**.

[0030] A base station antenna **44** receives radio frequency signals sent through the random access channel **42**. The received radio frequency signals are demodulated by a demodulator **46** to produce a baseband signal. The baseband signal is despread by a despreading device **48**. The despread data is separated so that the preamble and the non-preamble data are separated, such as by a demultiplexer **76**. A corresponding decoder **74** is used for both the non-preamble and the preamble data to recover the original data, such as by a decoder **74** and preamble decoder **76**. The decoded data is reassembled into the original data packet, such as by a multiplexer **78**. As a result, the transmitted preamble has a higher encoding gain than the non-preamble data. At the base station **24_1**, the preamble **54** is recoverable at a minimum power level increasing data throughput.

[0031] **Figure 7** is another simplified UE **24_1** and base station **22** for raising packet payload. A data packet generator **32** generates a data packet **52**. The data packet **52** is error encoded by an encoder **34**. The encoded packet is subsequently separated into its preamble and non-preamble data, such as by a demultiplexer **80**. The non-preamble data is spread by a spreading device **82**. The preamble is spread by a preamble spreading device **84** having a spreading factor higher than the non-preamble data spreading device **82**. The spread preamble and spread non-preamble data are combined, such as by a multiplexer **86**. The multiplexed data packet is modulated to radio frequency by the modulator **38** and radiated by an antenna **40**.

[0032] A base station antenna **44** receives radio frequency signals sent through the random access channel **42**. The received radio frequency signals are demodulated by a demodulator **46** to produce a baseband signal. The baseband

signal is processed using corresponding replicas of the spreading codes used to originally spread the preamble and non-preamble data, such as by a despreading device **88** and a preamble despreading device **90**. The despread preamble and packet data are reassembled, such as by a multiplexer **92**. The multiplexed packet is decoded, such as by a decoder **50**, to retrieve the original data packet.

[0033] As a result, the transmitted preamble **54** has a higher spreading factor than the non-preamble data **56**. At the base station **22**, the preamble data **54** is recoverable at the minimum initial power level.

* * *